

ROAD EQUIPMENT MANAGEMENT: A CHALLENGE FOR CAPACITY BUILDING OF LOCAL CONTRACTORS IN TANZANIA

by

Magesa Bairi* and Mrs. Marcelin Benedict**

ABSTRACT

The shortage of equipment and Plant needed for proper maintenance of roads, in particular the earth and gravel roads which compose majority of the road network seems to have prevailed too long in this country. This problem has greatly contributed to low participation of local contractors in the execution of works for construction and maintenance of roads. It has also been a cause of accusation of local contractors for poor performance in terms of quality and time of delivery.

Since independence, the government with the support of donor community and some institutions in the construction industry has endeavored in vain to put in place an appropriate and workable system to manage and maintain road maintenance equipment and plant. However, the need for the supply of reliable and adequate Plant and Equipment to the construction industry has become so critical that both short and long-term measures must be sought. The problem is further exacerbated by the fact that, the purchasing power of local contractors continues to decrease rendering them unable to purchase new equipment. Information available from various sources indicates that, local contractors have substantial number of equipment in dilapidated mechanical condition due to either age or poor maintenance management.

This paper discusses key factors attributable to poor maintenance management of equipment in Tanzania, and some basic elements of maintenance management of construction equipment. Finally the paper proposes some measures, which could improve management of construction equipment and henceforth improve their performance and their respective economic life.

1. BACKGROUND

The shortage of equipment and Plant needed for proper maintenance of roads, in particular the earth and gravel roads which compose majority of the road network seems to have prevailed too long in this country. This problem has greatly contributed to low participation of local contractors in the execution of works for construction and maintenance of roads. It has also been a cause of accusation of local contractors of poor performance in terms of quality and time of delivery.

On the other hand, the construction industry has for too long been dominated by foreign firms to extent of controlling more than 90% of the market share of work opportunities in Tanzania. This is not a good trend if this country has to build up a sustainable construction industry. It

* Assistant Registrar, Contractors Registration Board

** Senior Mechanical Engineer, Ministry of Works

is in this respect that it becomes imperative to develop a strong, dynamic and competitive domestic construction service sector through capacity building of local contractors.

After independence in 1961, the Government of the republic of Tanzania with the support of World Bank, Donor Agencies and other national governments e.g. USA, Canada, Norway, Sweden and Japan has endeavored to improve the availability and management of road construction equipment. For example in 1972, the Government established the Trunk Roads Maintenance Organization (TRM). This was implementation of recommendations of previous studies (1,2), which had proposed proper management of construction equipment. The government sought the assistance of World Bank to equip the TRM units. Thus, the Fourth Highway Project (1975) and the Fifth Highway Project (1979) addressed the problem of equipment availability by purchasing a total of 294 items of plant and 371 vehicles.

In 1986 under Sixth Highway Project, despite the demand for new equipment for road maintenance, no new equipment was supplied, but the project set aside a substantial amount of money to rehabilitate the plant and equipment purchased under the Fourth and Fifth Highway Projects. The rehabilitation exercise was not very successful, and thus could not improve the situation of equipment availability in the sector.

Furthermore, at the start of Integrated Roads Project (IRP) in 1990, the government agreed to reorganize the management of road maintenance plant and equipment. This was to be done through establishment of an autonomous Government and private plant pool which involved commercialization of the management of construction equipment previously owned by the Government under the ministry responsible for roads. This was deliberate effort by the government in trying to optimize utilization of available equipment and in the process build the capacity of local contractors through availing construction equipment to the sector.

It was envisaged that appropriate Management would be administered to Roads Equipment and Plant now placed under commercially oriented Plant Pools. This was the conclusion drawn from previous studies which had shown that equipment under Government departments were poorly managed, and hence had poor performance and reduced economic life.

However, neither the establishment of Private Plant Pools nor PEHCOL have been able to reduce the problem of Equipment needed for road maintenance in our country. Consequently, a number of various options have been proposed all aimed at improving equipment availability situation. The options include:

- ✓ Improving existing road workshops
- ✓ Privatization of PEHCOL
- ✓ Improving management of the existing equipment
- ✓ Establishment of plant hire departments by contractors
- ✓ Building capacity of local contractors

A number of strategies will be, or are being, implemented by various institutions in the construction industry like Contractors Registration Board (CRB), National Construction Council (NCC), Tanzania Civil Engineering Contractors Association (TACECA), and Tanzania Technology Transfer Center etc. These include Training programs to contractors, establishment of the Construction Trust Fund, Creation of Contractors Bank Guarantee Facility, and Joint Venture Arrangements all aimed at enhancing the capacity of local contractors.

Information available from various sources (3, 4) indicates that, local contractors hold quite a reasonable number of construction equipment. But the equipment is over aged and in poor mechanical conditions. Consequently, their output has been quite low. In consideration of the high cost of buying new equipment and the low purchasing power of local contractors, improving equipment management of the existing fleet looks to be a viable short term measure. The strategy would improve equipment availability through reducing the frequency of Equipment breakdown, proper utilization of equipment and capturing realistic equipment costs.

This paper intends to discuss how the capacity of local contractors could be improved through effective management of the existing fleet.

2.0 CURRENT SITUATION OF CONSTRUCTION EQUIPMENT

2.1 Plant Available from Local Contractors

Information collected by CRB through Annual Return Forms submitted by a total of 703 (40%) registered contractors for the year 1999 indicate that Civil Contractors who represent 31% of total registered contractors own more construction equipment than other types of contractors i.e. building, mechanical, electrical and specialized contractors. The composition of fleet owned by local contractors which is shown in **Table 1**, is only suitable for periodic and routine maintenance of unpaved roads.

Table 1. EQUIPMENTS OWNED BY LOCAL CONTRACTORS

Table 1(a) Building Contractors

Class	Equipment & Tools																	
	Tower (Building) crane	Bull Dozer (Min capacity 120 HP)	Graders (Min capacity 100HP)	Loaders (Min capacity 100HP)	Vibrating rollers (Min capacity 10 HP)	Tandem rollers (Min capacity 10 HP)	Pneumatic Tyre rollers	Pedestrian Roller/Plate compactor s	Water Bowlers/ Trailer	Bitumen Sprayer	Bitumen Boiler	Heavy Duty Truck (25T)	Back hoes/ Excavators	Agriculture Tractor/ Loaders	Stone Crusher	Chips Spreader	Asphalt Plant	Concrete Batching machine
I	11	3	1	6	15	4	0	7	1	0	1	4	5	1	2	0	0	0
II	1	0	0	1	0	0	0	0	1	0	0	0	0	2	5	0	0	0
III	0	0	0	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0
IV	0	1	2	1	3	0	0	0	1	0	0	0	3	0	0	0	0	0
V	0	0	2	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
VI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VII	0	0	0	0	1	0	0	3	4	1	0	0	1	5	1	0	0	0
TOTAL	12	4	5	9	21	4	2	11	7	1	1	4	10	9	8	0	0	0

Table 1(b) Building/ Civil Contractors

I	4	16	19	25	20	4	1	5	22	9	9	4	26	10	3	2	3	3
II	0	4	1	4	4	0	0	0	2	1	0	0	1	2	0	0	0	0
III	1	8	6	6	6	1	0	6	3	2	0	2	14	2	2	0	0	0
IV	0	0	4	0	2	0	0	5	2	0	0	0	0	3	0	0	0	0
V	0	0	4	0	0	0	0	2	5	0	0	0	2	3	1	0	0	0
VI	0	1	4	0	1	0	0	1	4	0	0	0	2	4	0	0	0	0
VII	0	1	4	2	0	0	0	4	4	0	0	0	0	5	0	0	0	1
TOTAL	5	30	42	37	33	5	1	23	42	12	9	6	45	29	6	2	3	4

Table 1(c) Civil Contractors

I	29	56	38	71	57	17	10	68	55	9	0	26	56	38	31	3	2	3
II	0	2	3	4	2	0	0	1	2	0	0	0	3	0	1	0	0	0
III	0	9	7	9	7	0	0	2	4	0	0	0	0	4	0	0	0	0
IV	0	2	5	5	4	0	0	3	9	0	0	0	5	4	0	0	0	1
V	0	3	7	3	5	0	0	3	8	0	0	2	1	2	0	0	0	0
VI	0	2	2	3	2	0	0	3	7	0	0	0	0	2	1	0	0	0
VII	0	5	2	3	3	0	0	8	9	0	0	0	2	3	1	0	0	1
TOTAL	29	79	64	98	80	17	10	88	94	9	1	28	67	53	34	3	2	5

GRAND TOTAL	46	113	111	144	134	26	13	122	143	22	11	38	122	91	48	5	5	9
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Source: Contractors Annual Returns – CRB

Except for some few local contractors, most contractors acquired heavy construction equipment in second hand conditions, some of which had been purchased from either foreign contractors or government institutions. Degradation or the declines in value and economical usefulness of equipment with age coupled with poor management have significantly contributed to current mechanical conditions of existing equipment. In fact this is what was reflected in a study conducted in 1995 (3) to assess equipment situation in our country. In this study it was revealed that although local contractors seemed to own a good number of construction equipment, but when mechanical condition and age were considered, the equipment and plant revealed very low reliability index as shown in **Table 2**. For example, reliability index for dozers was only 9% i.e. 80 dozers were equivalent to 7 new dozers.

As a result such plant and equipment are generally characterized by low productivity and high operating costs which are a functions of use and age. Consequently, the plant and equipment have poor performance and low equipment utilization levels.

Except in very few cases, most of the construction equipment owned by local contractors are not worth retaining due age and high operating costs. In equipment management, there comes a time when it is not only economically justifiable to replace the present aging fleet, but economically beneficial in order to obtain equipment which has great output and reliability.

Table 2: Summary of Available Plant and Equipment

Type of Equipment	PEHCOL		ROAD WORKSHOP		CONTRACTORS		TOTAL AVAILA BLE	TOTAL EQUIV. NEW
	Available	Equiv. New	Available	Equiv. New	Available	Equiv. New		
Graders (130 – 140HP)	11	2	17	6	89	12	117	20
Rollers Vibratory. (8 – 10 Tons)	4	0	3	1	99	40	106	41
Dozers (100 – 150 HP)	8	1	7	2	86	7	101	10
Wheel Loaders (1.5 – 2.0 m ³)	8	1	13	5	85	9	106	15
Water Bowsers (6000 – 9000 Liters)	0	0	0	0	116	46	116	46
Crushers (30 – 50 Tons)	0	0	0	0	31	15	31	15
Asphalt Plant 50 Tons /Hour	0	0	0	0	2	0	2	0
Pavers (2.5 – 7 mts)	0	0	0	0	0	0	0	0
Bitumen Sprayer (6000 – 8000 Liters)	0	0	0	0	13	4	13	4
Pneumatic Rollers (8- 10 Tons)	0	0	2	0	4	1	6	1
Static Rollers (4 – 8 Tons)	0	0	0	0	6	1	7	1
Chip Spreader	0	0	0	0	1	0	1	1
Tower cranes	0	0	0	0	33	16	33	16

Source: Ministry of Works (Prof. J.S. Mshana's Report, 1995)

Note: Equivalent number of new plant and equipment is obtained by multiplying the average reliability index by the total number of equipment.

For example comparing Equipment fleet sizes owned by local contractors to respective annual turnovers, the annual turnovers, which are very low, do not justify the size of the fleet holdings. In one case, a contractor registered as civil contractor class four with annual turnover of Tsh. 62 million had the fleet size as shown in **Table 3**.

Table 3: Equipment Revenue

Plant Type	Quantity	Hire Rates Per Day Tshs.	Annual Expected Revenue Tshs.
Bulldozer	1	336,000	33,600,000
Grader	1	267,000	48,060,000
Wheel Loaders	2	310,000	110,000,000
Vibrating Roller	1	190,000	19,000,000
Water Bowzer	1	100,000	10,000,000
Excavator	1	262,000	26,000,000
Low loader	1	300,000	30,000,000

Source: Contractors Annual Return Forms – Contractors Registration Board

If equipment in the fleet were hired with at least 50% utilization, the annual turnover would be more than Tsh. 276 mil. In other words, it is not economical to continue owning such a fleet size for construction purposes. In fact it is not usually economical for contractors to own plant and equipment unless they can ensure at least 75% to 80% utilization factor.

2.2 Plant Available from Foreign Contractors

Foreign contractors who represent about 4% of the total registered contractors and undertake more than 75% of market share of construction activities own construction equipment, which only meet their specific contracts. In terms of numbers they have relatively small fleets of construction equipment but with very high productivity, high reliability, high availability and full utilization.

The equipment owned by foreign contractors is shown in **Table 4**. The fleet composition contain Crushing Plant, Asphalt Plant, Bitumen Boiler (heater), Bitumen Sprayer, Chip Spreader, Pneumatic and Steel wheel rollers which are essentially required for maintenance and construction of paved roads.

Table 4 EQUIPMENT OWNED BY FOREIGN CONTRACTORS

Type of contractor	Equipment & Tools																	
	Tower (Building crane)	Bull Dozer (Min capacity 120 HP)	Graders (Min capacity 100HP)	Loaders (Min capacity 100HP)	Vibrating rollers (Min capacity 10 HP)	Tandem rollers (Min capacity 10 HP)	Pneumatic Tyre rollers	Pedestrian Roller/Plat e compactor s	Water Bowlers/ Trailer	Bitumen Sprayer	Bitumen Boiler	Heavy Duty Truck (25T)	Back hoes/ Excavators	Agricultural Tractor/ Loaders	Stone Crusher	Chips Spreader	Asphalt Plant	Concrete Batching machine
Building	5	0	0	2	4	1	0	2	1	0	0	2	4	0	0	0	0	0
Building/Civil	4	5	4	11	3	3	0	2	7	3	1	3	9	4	6	1	1	3
Civil	24	22	18	46	28	16	9	63	19	6	0	4	38	23	11	3	2	3
TOTAL	33	27	22	59	35	20	9	67	27	9	1	9	51	27	17	4	3	6

Source: Contractors Annual Returns – CRB

Construction equipment owned by foreign contractors do not in fact augment the shortage of construction equipment as these are tied up to specific large size contracts and are not available for hire to local contractors. However, some of these equipment gets into the hands of local contractors once some projects are completed or when they disposed of.

2.3 Plant available from Plant Hire Companies

The existing Plant Hire companies in Tanzania are of two types, namely government and private plant pools. Government Hire companies include PEHCOL and road workshops in Tanga, Mbeya and Morogoro and some few Equipment Hire Units (EHU) established by Regional Engineers. While these road workshops provide services on a priority basis to respective Regional Engineers (now Regional Managers), PEHCOL has no such restrictions. It is estimated that Road workshops cover more than 80% of the plant hire market in their respective regions (5). However, it is estimated that in total plant hire companies capture between 15 – 20 % of total equipment market share. Major Plant and Equipment owned by Road Workshops are showed in **Table 5**.

Generally most of the equipment owned by private Plant Hire Companies was acquired in second hand conditions. The age factor and poor maintenance services of the fleet owned result in high operating and maintenance costs and low equipment utilization. Consequently, low revenue collection and equipment profitability.

Table 5: PEHCOL and Road Workshops Plant and equipment

Plant Type	Tanga	Morogoro	Mbeya	PEHCOL	Total
Graders	6	2	9	11	28
Dozers	2	2	3	8	15
Rollers	1	1	1	4	7
Wheel Loaders	5	2	6	8	21
TIPPERS	11	10	21	17	59

Source: Reports of respective Plant Pools

Due to low equipment performance the revenue collected from plant hiring does not make these companies sustainable despite economical hire rates shown in **Table 6**.

Table 6: Average Hire Rates

Type of Equipment	Lowest Rates	Highest Rate/Day	Average Tshs./Day
Graders	180,000	315,000	267,000
Bulldozer	212,500	415,000	336,000
Vibratory Rollers	180,000	200,000	190,000
Wheelloaders	220,000	420,000	310,000
Concrete Mixer	20,000	27,000	23,000
Excavator	225,000	300,000	262,000
Water Bowser	60,000	80,000	73,000

Source: Contractors Annual Return Forms- CRB

Table 7: Plant Economical Owning Period:

Plant /Equipment type	Estimated economical period with 75-80% utilization factor
Hydraulic Excavators (large)	9 years
Loaders/shovels	9 years
Dozers/Scrapers	10 years
Mobile Cranes	12 years
Crawler Cranes	15 years
Dump Trucks	8 years
Dampers	6 years
Rollers/Compaction	6 years
Compressors/Generators	7 – 9 years
Light Duty vehicles	6 – 7 years
Tippers	6 years

Source: Caterpillar Plant and Equipment Handbook

The age of construction equipment owned by both government and private plant hire companies ranges between 15 – 20 years. This is beyond the estimated economical owning periods for such plant and equipment as shown in **Table 7**.

These plant hire companies have limited capacity to make potential investment in construction equipment due to poor financial cash flow, high equipment operating costs and poor equipment market demand. Eventually this has negative impact in their capacity to provide required services to equipment that is prerequisite to high equipment availability.

2.4 Capacity of Local Contractors

The problem of equipment availability is more serious for Civil works contractors below Class four whose average annual turnover is below Tsh. 79.0 million. In other words a Civil works contractor below classes four is not financially capable to buy heavy construction equipment such as a motor grader or a wheel loader whose prices are about \$180,000 and \$120,000 respectively. Looking at the annual Turnover for classes One to Three (**Tables 8**), it can be observed that the purchasing power of local contractors is very low.

Table 8: Annual Turnovers 1999.

a) Local Contractors

Class (Local)	Building Contractors	Civil Contractors
	Average Turnover (Mill. TShs.)	Average Turnover (Mill. TShs.)
I	342.7	961.3
II	99.9	168.4
III	154	83.4
IV	50.1	79.4
V	77.3	63.3
VI	16.0	29.8
VII	60.8	20.8

b) Foreign Contractors

	Building Contractor	Civil Contractors
Class (Foreign)	Average Turnover (Mill. TShs.)	Average Turnover (Mill. TShs.)
I	1552.3	8427.5

Source: Contractors Annual Returns – CRB

Looking at **Table 9**, the average contract size for building and civil works contractors in classes four to seven varies between Tsh. 38 – 12 mil and Tsh. 52 – 17 mil respectively. Similarly the Annual turnover ranges between Tsh. 60 – 16 and Tsh. 79 – 20 respectively. There is no way such a contractor can acquire even single heavy construction equipment from the contract payment.

Table 9: Average Size of Contract

a) Building Work Contracts

Class	Overall	Local			Foreign		
		Contract size (Million Tshs)	Range of Contract size		Contract size (Million Tshs)	Range of Contract size	
			Maximum (Million Tshs)	Minimum (Million Tshs)		Maximum (Million Tshs)	Minimum (Million Tshs)
I	654.11	136.58	630	15	2,413.73	8,000	342
II	80.79	80.79	232.22	5.0	-		
III	61.34	61.34	12.47	6.0	-		
IV	38.87	38.87	152	0.848	-		
V	30.47	30.47	557.1	0.208	-		
VI	13.45	13.45	64	0.045	-		
VII	12.19	12.19	280	0.143	-		

b) Civil Work contracts.

Class	Overall Contract size (Million Tshs)	Contract size (Million Tshs)	Local		Foreign		
			Range of Contract size		Contract size (Million Tshs)	Range of Contract size	
			Maximum (Million Tshs)	Minimum (Million Tshs)		Maximum (Million Tshs)	Minimum (Million Tshs)
I	651.53	221.43	695.6	13.9	1,855.8	5,360	15
II	83.72	83.72	339.0	10.0	-	-	-
III	49.44	49.44	480.0	2.696	-	-	-
IV	52.39	52.39	450	0.385	-	-	-
V	26.36	26.36	138.98	2.644	-	-	-
VI	27.35	27.35	346.62	0.87	-	-	-
VII	17.55	17.55	200.0	0.70	-	-	-

Source: Contractors Annual Returns - CRB

3.0 CONSTRUCTION EQUIPMENT MANAGEMENT

3.1 Objective

When equipment is used in construction works, the equipment related expense would differ greatly depending on the standard of equipment administration and maintenance management. For example in some construction works, equipment related costs vary between 27 – 40% of the total project costs. Therefore, the standard of equipment management has an extremely large effect on the execution of the project. The objective therefore is to try to improve the safety and quality of the project by mechanized execution, and to reduce the duration and costs of the project. This could be achieved by carrying the necessary equipment to site, maintaining equipment in good working condition, training and keeping competent operators.

3.2 Elements of Maintenance Management of Construction Equipment

3.2.1 Equipment planning and selection

Many construction operations have two or more types of equipment working together. Therefore, in order for them to work together effectively and economically, their rates of production must be balanced in size and productivity. For example, if the Loader has a bucket of 3 – 4 m³ capacity, then the hauling units should have capacities of say 3, 4, 6 m³.

In equipment planning, the following should be considered:

- Equipment should be selected to enhance the operating efficiency of each equipment used in combination.
- The working capacities of every equipment used in combination should be matched.

3.2.2 Maintenance management of equipment

Planning and implementation of maintenance tasks which includes the method and timing of maintenance, storage of equipment, repair measures, parts stocking etc. aims at keeping the equipment in reliable and maintainable condition. The program targets to lessen equipment failures, shorten downtime due to equipment failure and to repair the equipment at less cost.

Basically, there are two types of maintenance programs. These are Corrective Maintenance and Preventive Maintenance programs. Corrective Maintenance, which involves emergency, remedial and unscheduled repairs, is a reactive as opposed to proactive mode of maintenance. It is based on the policy of **‘operate the equipment until it breaks down and then repair’**. Consequently, corrective maintenance is more costly than preventive maintenance.

Preventive Maintenance aims at preventing failure, detecting onset failure and discovering a hidden failure. This is a program, which endeavors to anticipate failure and the adoption of necessary preventive action before they occur.

3.2.3 Operator management

The correct use and operation of construction equipment are fundamental in improving productivity and reducing costs. Experience has shown that, however good may be the performance of a construction equipment, or the maintenance management may be, the operators skill in operating the equipment greatly governs its working efficiency. Therefore, operator management becomes very important. This requires that the operators working environment,

living condition, health human relationship and remuneration package be suitably taken care of.

3.2.4 Transportation and storage of equipment

In order to ensure safety and high operating efficiency of construction equipment, proper management during transportation and storage of equipment is very important. Before doing any transportation of equipment is important to decide on the method of transportation and make a detailed plan on the use of the equipment at site. The author of this paper once witnessed a good working Grader (Champion) falling down from a low loader due to poor fastening and parking. The equipment was damaged beyond repair. The reader can just imagine how much money was lost due to sheer negligence.

In the case of storage of equipment, which is not under use, the following measures must be taken care of:

- Clean all parts of the equipment.
- Take action to prevent rusting of parts.
- Drain out the cooling water.
- Cover all openings.
- Use wooden blocks to keep tires off the ground, for wheeled equipment.

3.2.5 Replacement of equipment

One way of keeping the fleet size at manageable level is by replacing those equipment beyond their economic life with new ones. This helps to improve the general performance of the fleet. However, this can only be achieved if your costing structure is designed to clearly capture and produce (actual) running costs of each machine and you are able to project the costs of the machine over its life cycle.

4.0 SOURCES OF MAINTENANCE MANAGEMENT PROBLEMS IN TANZANIA

4.1 Spare Parts Availability

Spare parts non-availability has greatly contributed to the present state of poor management of maintenance of construction Equipment and Plant in Tanzania. It is often a problem to plan for and effectively implement equipment maintenance and repair schedules due to the problem of spare parts availability at the right time, in the right place and in the required quality and quantity.

Despite the adoption of trade liberalization policy in Tanzania, construction equipment have no reliable and dependable supplier of spare parts. Furthermore, those spare parts, which happen to be available, are extremely expensive as a result of related importation taxes. This causes construction Equipment unserviceable for long periods awaiting spare parts, and this increases the cost of equipment downtime. When spares cannot be readily available, and easily purchased, any efforts to plan for periodic overhauls, inspection programs, preventive and corrective maintenance schedules becomes unsuccessful exercise.

This problem of spare parts availability is made more complex by the fact that, local contractors own equipment, which are very old and of different makes and models. For example one

registered contractor in Class one has fleet size as shown in **Table 10**. Obviously, considering the age of the fleet composition and various makes and model, such a contractor is likely to face spare part problem.

Table 10: Construction Equipment owned by a registered contractor

Item	Nos.	Make	Age in Year
Bulldozers		Caterpillar D4	36
		Caterpillar D6C	30
		Caterpillar D6D	20
		Komatsu D41	20
		Komatsu D53	20
		Komatsu D65	20
		Komatsu D85	17
		Komatsu D85	11
Wheel loaders		Michigan 125	30
		Case W20	30
		Volvo BM4300	30
		Case 580 B	30
		Caterpillar 950 B	11
		Caterpillar 930	12
		Komatsu WA450	13
		Caterpillar 955 L	20
Trexcavator		Caterpillar 140G	15
Motor grader		Caterpillar 12 F	20
		Galion 118	18
		Komatsu GD600	14
		Poclain 4X4 LY	20
		Hitachi	20
Excavators		Hitachi EX 100	20
		Liebher A 901 B	12
		Dynapac CG 11	30
Compactors Vibratory		Vibromax 1101	30
		Dynapac LR 50	30
		Dynapac CA 15	20
		Dynapac CA 25	15
		Dynapac CA 25	13
		Dynapac CA 51	13

Source: Contractors Registration Board.

4.2.1 Financial constraints.

Financial constraints are one of the major problems facing local contractors in Tanzania. The argument put forward by at least most of these contractors for low financial capacity includes late payment by clients, small contract sizes and non-availability of job opportunities. Consequently, they find it very difficult to maintain even the equipment they happen to own. This in turn leaves the local contractors with the same old equipment with insufficient funds to cater for their maintenance.

There is also a problem of lack of funds for maintenance tasks due to low or unrealistic maintenance budget. In most cases this is caused by ignorance by top management, poor maintenance records, and lack of qualified plant mechanics and poor financial management.

4.3 Training of Maintenance Personnel

Lack or absence of qualified maintenance personnel with specialized technical skills in construction equipment is another cause of poor management of maintenance activities. This in most cases has led to improper operation and maintenance of equipment, which shortens equipment economic life, efficiency and increases downtime.

From a study conducted in 1994 (6), it was revealed that, more than 67% of the organizations that own construction equipment had no formal training policy for plant operators and mechanics, even though more than 81% agreed that there was need to train plant operators and mechanics. Poor training policy in these organizations have resulted in poor maintenance planning and control and poor quality of maintenance work etc. This problem is also exacerbated by lack of specialized training institutions and programs for plant operators and plant mechanics.

A quick look at some information from local contractors owning a good number of construction equipment revealed that only very few have competent plant mechanics. Many of these contractors have few mechanics reportedly to have acquired experience in construction equipment and plant. But with the current trend of fast change in technological advancement in Construction Equipment, experience alone is not sufficient for one to master in depth the technical know why to every type of equipment. Each type of equipment has different maintenance procedures. Therefore, considering the many makes and models owned by local contractors, the chance of one mechanic mastering the appropriate knowledge required to each equipment is very narrow by having the mechanic moving from one type of equipment to another.

4.4.1 Maintenance records

Important to implementing effective management of maintenance of construction equipment, is the proper recording and documentation of equipment maintenance records and reports.

Such records indicates maintenance manpower man hours available, hours planned for maintenance work, actual hours worked for maintenance, overtime hours, preventive and corrective maintenance hours, maintenance costs, causes of equipment breakdown, maintenance skills required, detailed description of equipment, equipment operating hours, total labor and material costs etc. These data or reports will assist the organization in: -

- (a) Tracking down equipment maintenance cost trends.
- (b) Assessing the effectiveness of maintenance programs.
- (c) Equipment replacements analysis.
- (d) Planning and control of maintenance spares and materials.
- (e) Establishment of maintenance organization.

It is quite impossible to have maintenance cost control in place and equipment life cycle cost analysis when proper records of maintenance and operating cost on equipment are not accurately kept.

Audited accounts submitted to Contractors Registration Board from three civil contractors (local) registered in class one gave the following information on maintenance and repair of construction equipment as shown in **Table 11**

Table: 11 Maintenance Costs

Type of cost as %of Annual Turnover	Contractor A	Contractor B	Contractor C
Repair and maintenance cost	0.2%	11.4%	0.15%
Fuel and lubricant cost	0.13%	19.3%	5%

Source: Audited Reports submitted by contractors

Looking at such information it likely for one to conclude that something is wrong with the keeping of data for contractors A and C. Similarly, if data by contractor B happens to be true, then the maintenance cost and running cost of the fleet size is on the higher side.

4.5 Equipment Costs

Each type of cost incurred to every construction equipment in its lifetime is supposed to be properly recorded and taken account of. This is vital information when the management has to make decisions concerning choice of equipment, equipment life and replacement.

Basically, there are two types of Equipment costs. These are Equipment operating and Ownership costs. The former would include charges for the operator, fuel and lubricant costs, costs of repairs and tire replacement. Equipment ownership costs are those expenses that the owner of equipment must take account to evaluate and project his investment. These would include costs on interest for borrowed money, taxes, insurance, depreciation costs etc.

It is very crucial for the revenue accrued from use of each equipment to be recorded so that it could be established whether the item is earning an adequate return on the invested capital and determined profitability.

It has been observed that some of local contractors fail to properly indicate the actual costs for owning and operating construction equipment. This results from poor recording keeping. A good equipment management system requires proper accounting of these costs. Failure to this may lead to:

- Inadequate attention to effective equipment utilization
- Over investment in equipment fleet
- Tendency to maintain and operate equipment which is already beyond economic life
- Unrealistic equipment maintenance budget
- Inadequate information to make proper analysis on actual return on invested capital on equipment.

Many contractors do not realize how much money they loose through unrealistic costing of equipment until when they want to replace aging equipment. Consequently, they fail to replace their fleet on a sustainable basis and hence remain with equipment in aged and scrap condition.

4.6.1 Maintenance culture

While in developed countries, good maintenance culture has diffused through the society; it has not been the case in developing countries in particular African countries. Maintenance culture is an attitude whereby facilities, systems and structures are kept in functional and safe conditions at minimum costs. It was observed by Odhiambo (7), “ what is desperately required today in Africa is to construct a new culture of the repair and servicing of scientific equipment and of the maintenance and reconstruction of every important item of such equipment”.

Lack of maintenance culture on maintenance management of construction equipment by contractors has in many ways resulted in wasted revenues, poor performance, late delivery of projects, premature breakdown of equipment, high cost of repair, equipment related accidents etc.

Problems of maintenance culture could be due to a number of reasons including ignorance, poor state of the economy and lack of technology transfer, poverty etc.

4.6.2 Workshop facilities

Construction equipment are expensive machines and should be carefully handled, maintained and repaired by trained and experienced operators and mechanics. They also require appropriate tools and facilities in carrying out maintenance tasks.

However, very few local contractors have well-established workshops with proper tools for specific tasks in repairing of construction equipment. Furthermore, lack of private workshops either owned by individuals firms or equipment dealers aggravate the problem of poor maintenance of construction equipment. Poor repair of the equipment obviously tend to reduce the economic lives of these equipment.

5.0 WHAT SHOULD BE DONE

5.1 Training

In order to make our contractors to grasp the significance of management of construction equipment, proper training should be arranged for contractors who own construction equipment. Specific courses on how to cost a piece of equipment, selection and planning of construction equipment, maintenance planning etc. should be conducted.

Furthermore, regular training of plant operators and mechanics should be looked at as indispensable programs if contractors are to continue owning equipment in reliable condition. Although this may be looked at as unnecessary cost worth avoiding, but in the long run, it could save contractors from lost revenue due to frequent equipment breakdown, lost time due to high equipment downtime and high cost of maintenance and repair.

5.1.1 Improving maintenance management

Experience has shown that some construction equipment owned by our local contractors could have their economic life extended if they got proper maintenance. This would involve having effective equipment inspection, maintenance schedules, qualified and skilled maintenance personnel, lubrication management, proper maintenance records, equipment performance analysis, maintenance standard setting, etc.

In order to carry out effective maintenance management, it is for contractors to reduce their fleet sizes to economical and manageable levels. This could involve reducing as well as the number of makes one would hold.

5.1.2

5.1.3 Improving workshops and workshop facilities

Contractors should consider establishing or improving existing workshops facilities for servicing and repairing their own equipment. But, before you decide to set your own workshop, you should ask yourself the following important questions:

- The type and number of equipment you need to maintain
- The kind of facilities, mechanics, tools and equipment needed to carry out services and repairs
- The cost involved to carry out the services and repairs in your own workshop compared to that done by an agent or garage

However, it should be noted that, the bigger the fleet sizes, the more economic it is to set your own workshop. But, with little construction equipment it is worth to contract out repairs and maintenance services to reputable workshops.

5.1.4 Setting up of equipment overhaul policy

Instead of replacing old equipment with new ones, major overhaul could be carried to old machines. This implies that the overhauled machine should meet the performance of a new machine in all respects including running costs and reliability. Whereas a minor overhaul could be up to 25%, a typical major overhaul could cost up to 50% of a new machine's purchase price. However, major overhauls require competent plant mechanics, spare parts specialist and well-established workshops. Therefore, this could adequately be carried at specific dealers of construction equipment.

Each contractor could come up with own overhaul policies for each type of equipment. For example you could set different overhaul policies to graders, loaders, haul trucks, etc. For example, one could set a policy for minor overhaul at 25% and 75% life of machinery, whereas major overhauls being at 50% of life of the machine.

5.1.5 Fleet rationalization/standardization

It has been discussed earlier that, one of the sources of poor maintenance management of construction equipment owned by local contractors is the multiplicity of different types, makes, models and age of different machines. This causes problems in servicing of the equipment due to requirement of multiple numbers of spare parts and skilled mechanics and operators. In order to reduce this problem, contractors should standardize on one or few makes and models.

6.0 CONCLUSION AND RECOMMENDATIONS

Availability of Plant and Equipment in the open market is a precondition to enable effective and wide participation of local contractors in the construction works. The general performance of available fleet owned by both local contractors and Plant hire companies is very poor as a result of age and poor equipment management. Moreover, the capacity of local contractors to acquire new construction equipment is very low. This therefore calls for deliberate strategies to improve performance of the existing fleet through effective maintenance management.

It is recommended that a thorough study should be conducted to ascertain the actual numbers and mechanical conditions of Plant and Equipment per type owned by both local and foreign contractors. This would enable the government to know the actual status of construction equipment available and future demands.

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